Solar Decathlon Building Code

1. Introduction

Although there is some degree of overlap between the two, it is important to note some crucial distinctions between the Competition Regulations and the Solar Decathlon Building Code. The Competition Regulations exist to promote a fair and interesting competition. The Solar Decathlon Building Code exists to protect the public health and ensure safety. Failure to comply with the Competition Regulations may result in official warnings, point penalties, or disqualification from the Competition. Failure to comply with the Solar Decathlon Building Code prohibits the participation of your house in any aspect of the overall Event. Therefore, compliance with the Solar Decathlon Building Code is a prerequisite for participation in the Competition.

2. Adopted Codes

The 2006 International Residential Code of the International Code Council and the 2005 National Electric Code of the National Fire Protection Agency have been adopted by reference as the Solar Decathlon Building Code and have the same force and effect as though fully set forth in the 2007 Solar Decathlon Rules and Regulations, except as specifically amended by provisions in the 2007 Solar Decathlon Rules and Regulations.

3. National Park Service Regulations

3.1 Professional Engineer Stamp

The National Park Service (NPS) requires that structural drawings and calculations are stamped by a Professional Engineer (P.E.) certifying that the structures are safe for the public to enter. Refer to Section 6 for structural design criteria.

3.2 Public Tours

3.2.1. Accessible Route and Means of Egress

The public will have access to all the structures within the Solar Decathlon village at various times during the Event; therefore, all structures must meet the specific accessibility requirements in Section 5: Accessibility. Teams are required to provide an accessible route to all portions of the house and exterior that are available to the public during the tour. This does not mean that the entire house needs to be accessible.

The house shall be designed to meet the Means of Egress provisions in Section 4.2. These requirements supersede and replace those contained in IRC Section 311.

3.2.2. Handouts

Teams are permitted to give one and only one informational brochure/handout to each member of the general public. No other handouts are permitted.

3.2.3. Sale of Items

Teams are prohibited from selling items to the general public on the National Mall.

3.3 Sponsor Recognition on the National Mall

The NPS has strict rules that will affect the way in which the Solar Decathlon teams and Organizers recognize Team and Event Sponsors. The Solar Decathlon Organizers also have developed rules that affect sponsor recognition. The Organizers reviewed the relevant NPS document regulating events on the National Mall in Washington, D.C., National Capital Field Area (NCFA) Requirements for Special Events Held on Parkland, as a starting point to develop the guidelines contained in this document. The Solar Decathlon Rules and Regulations Committee provided additional guidelines. The Organizers consult regularly with NPS regarding all plans for the Solar Decathlon, and the Rules and Regulations Committee meets regularly in an ongoing process of developing rules and regulations for the Project. Additional guidelines may be developed at a later date. The Organizers interpret NPS rules and regulations to the best of their abilities. They will attempt to get clear approval from NPS for plans for the Event at all times, but NPS has the final word in these matters. It is possible that despite this guidance, a team may be requested to remove items NPS does not consider appropriate for the Event.

Within certain restrictions, it is possible for teams to use their sponsors' logos in and on their Solar Decathlon houses. These restrictions apply but are not limited to all communications materials that will be on display or distributed at the Event on the National Mall. These restrictions apply to both the interior and exterior of your house. Any communications materials may be used only to identify the Solar Decathlon or a portion of the Solar Decathlon (e.g., communications materials related to one of the Contests). Sponsors may be recognized with text, logos, or both, but the text and logos must appear in conjunction with Solar Decathlon text and logo and may not be larger than one-third the size of the Solar Decathlon text and logo. The use of commercial notices or advertisements, models of commercial products, or structures representing commercial products is strictly forbidden.

To provide guidance, the Organizers have developed requirements for some communications materials the teams may be considering. These requirements apply to but are not limited to the materials listed in this document. All communications materials, except those

prepared specifically for and viewed only by the judges for other Contests (e.g. materials prepared for the architecture jury), will support the goal of Contest 4: Communications—to educate consumers about energy efficiency and solar energy. Communications products will be targeted to an average consumer audience and will exist for the purposes of describing and explaining each team's house design, Construction, Assembly, functioning, and performance, including the solar energy and energy efficiency design strategies and technologies in the house, and each team's process and experience in the Project.

3.3.1. Signs, Exhibits, Posters

Signs, exhibits, and posters will exist only to support the goal of Contest 4 as described above. Signs, exhibits, and posters the Organizers determine do not support this goal, that exist largely for the recognition of sponsors, (or both) will be removed. All signs, exhibits, and posters should contain the Solar Decathlon logo or Solar Decathlon title text to clearly identify connection to the Event. If the content of signs, exhibits, and posters pertains to a specific component of the Event (e.g., one of the Contests), indicate to which component it pertains. Any text that refers to sponsors or any sponsor logos should not be greater than one-third the size of the Solar Decathlon title text, the text that identifies a specific component of the Event, or the Solar Decathlon logo. If sponsors are recognized through logos, the Solar Decathlon must be recognized using the Solar Decathlon logo. If text is used to recognize sponsors, either text or logo may be used to recognize the Solar Decathlon.

3.3.2. Plaques, Photos, and Wall Art

Plaques, photos, and wall art will exist only to add aesthetic value to the house or to support the goal of Contest 4 as described above. Plaques, photos, or wall art that the Organizers determine do not add aesthetic value to the house, do not support this goal, exist largely for the recognition of sponsors, (or any combination of the three) will be removed. Any plaques, photos, or wall art that recognize sponsors should contain the Solar Decathlon logo or Solar Decathlon title text to clearly identify their connection to the Event. If the content of the plaques, photos, or wall art pertains to a specific component of the Event (e.g., any of the Contests), indicate to which component it pertains. Any text that refers to sponsors or any sponsor logos should not be greater than one-third the size of the Solar Decathlon title text, the text that identifies a specific component of the Event, or the Solar Decathlon logo. If sponsors are recognized through logos, the Solar Decathlon must be recognized using the Solar Decathlon logo. If text is used to recognize sponsors, either text or logo may be used to recognize the Solar Decathlon.

3.3.3. Furnishings

Home furnishings (e.g., furniture, floor and window coverings, clocks, sculptures, knick knacks, figurines, and bookends) in the house will exist only to add aesthetic value. Any furnishings that are used to recognize sponsors will be removed.

3.3.4. Appliances and Electronics

"Off-the-shelf" appliances and electronics that feature a "built-in" manufacturer's logo are acceptable. Marketing and sales material will not be adhered or attached to appliances and electronics or distributed in any other way on the National Mall.

3.3.5. Publicity Materials and Printed Materials for Distribution on the National Mall

The teams' brochures, binder, or folder containing the Media/VIP kit, and any materials within the binder or folder (see Regulation 3.2: Event-Sponsor Recognition) should contain the Solar Decathlon logo or Solar Decathlon title text to clearly identify connection to the Event. If individual contents in the binder or folder pertain to specific components of the Event (e.g., one of the Contests), indicate to which component they pertain. Any text that refers to sponsors or any sponsor logos should not be greater than one-third the size of the Solar Decathlon title text, the text that identifies a specific component of the Solar Decathlon, or the Solar Decathlon logo. If sponsors are recognized through logos, the Solar Decathlon must be recognized using the Solar Decathlon logo. If text is used to recognize sponsors, either text or logo may be used to recognize the Solar Decathlon.

3.3.6. Video/Audio/Electronic Presentations

Video/audio/electronic presentations will exist only to support the goal of Contest 4 as described above. Video/audio/electronic presentations that the Organizers determine do not support this goal, exist largely for the recognition of sponsors, (or both) will be removed. All video/audio/electronic presentations should contain the Solar Decathlon logo or Solar Decathlon title text to clearly identify connection to the Event. If the content of video/audio/electronic presentations pertains to a specific component of the Event (e.g. any of the Contests), indicate to which component it pertains. Any text that refers to sponsors or any sponsor logos should not be greater than one-third the size of the Solar Decathlon title text, the Solar Decathlon logo, or the text that identifies a specific component of the Solar Decathlon. Audio scripts must be written and recorded such that their content supports the goal of Contest 4 and clearly identifies connection to the Solar Decathlon or a component of the Solar Decathlon (e.g., any of the Contests). No more than 20% of the total time, 1 minute, or whichever is less, of a video/audio/electronic presentation may be dedicated to recognition of sponsors. Television- or radio-style commercial advertising is prohibited. Video and audio loops, and screensavers that serve only to recognize sponsors are prohibited.

3.4 Food and Beverage

Only NPS-approved vendors can provide food and beverage to the visiting public on the National Mall.

3.5 Damage Liability

Each team is financially responsible for any damage it causes to the National Mall.

3.6 Construction Equipment

On the grassy areas, teams will be permitted to use a forklift or similar small lifting equipment to aid in the Assembly and Disassembly of their houses. However, forklifts or other small vehicles used during Assembly and Disassembly may be driven on the grass portion of the National Mall only if these vehicles are driven on an NPS-approved product designed to protect the grass. Truck-mounted cranes, trailers, semi-trailer trucks, etc., are limited to the gravel paths and may not be driven on the grass at any time. Under special circumstances approved by NPS and the Site Operations team, trailers and semi-trailers may be driven on the NPS-approved product.

3.7 Ground Penetration

No digging will be permitted except for tie-downs needed to meet wind loading requirements. Large stakes or screws, similar to those used for circus tents, may be used to anchor the structures. Screws or stakes used with tie-downs are limited to an 18-in. (45.7-cm) vertical depth. The NPS does make an exception to the 18-in. rule for the installation of grounding means for the house's electrical system. At certain times during the Assembly phase, an NPS representative will be on site to identify an acceptable location near each house for the installation of grounding means.

3.8 Impact on the Turf

Low-impact footings and tie-downs must be used to support structures on the grass portion of the National Mall. Teams will not be permitted to build or place floors directly on the grass.

Teams will be required to support all water tanks to minimize damage to the National Mall turf.

3.9 Driving

Teams are permitted to drive the electric vehicles on National Mall turf to enable charging or parking within a carport or garage or area close to the team's house. When an electric vehicle enters or exits the National Mall, it must be "walked" (accompanied by a student Team Member on foot in front of the car). The electric car must be walked from the parking area, carport, or garage to the street and vice versa.

3.10 Hydrogen Systems

Teams are responsible for getting hydrogen systems approved by the Washington, D.C. (DCFD) fire department. Written approval from DCFD must be received by the NPS before final approval can be considered. Since hydrogen gas does not contain an identifiable odor, all enclosed spaces containing hydrogen gas lines, fueled equipment, and or storage vessels must be provided with hydrogen gas detectors and alarms.

3.11 Spill Containment

Generators must be equipped with secondary containment systems that can accommodate all of the oil, fuel, and coolant that the generator contains at maximum capacities. All drains for appliances or sinks need to be routed back to a 350-gallon (1325-liter) minimum capacity tank to ensure that wastewater is not dispersed onto the National Mall turf or into storm drains. All wastewater and water used in Contest 7: Hot Water must be stored in the wastewater tank. During the Event, dumping of water on the lot will not be permitted, according to NPS rules.

4. Building Planning and Construction

The building is intended to be representative of a single-family dwelling constructed in accordance with the provisions contained in the International Residential Code (IRC). Because portions of the building will be open to viewing by the general public, specific provisions of the International Building Code (IBC) also apply.

4.1 Fire Protection and Prevention

4.1.1. Fire Protection Plan

Provide a fire protection plan. This plan should indicate the location of fire extinguishers, how egress will be made from the unit, and who will be responsible for life safety (the team's "Fire-Watch Captain") during the Event. Include a written operations plan for the fire-watch personnel. Successful demonstration of the plan will be required before any public tour of the building will be permitted.

4.1.2. Required Equipment

Each house will be required to have smoke alarms per IRC requirements and a fire extinguisher with a minimum Underwriters Laboratory (UL) rating of 2A-10BC. All battery system rooms or rooms containing a battery system enclosure must have a smoke detector that is either audible from outside the room or has a remote indicator that shall be monitored by the team. Smoke alarms shall be connected to the

AC voltage side of the inverter and provided with independent (with the alarm) battery backup. All alarms shall be interconnected and all shall sound when one is activated. (IRC, Sec. R313)

4.2 Means of Egress

The following means of egress components accessible to the public shall comply with Chapter 10 of the International Building Code.

4.2.1. Stairs

Stair treads shall be a minimum of 11 in. (27.9 cm) deep with risers a maximum of 7 in. (17.8 cm) high for any portion of the stairs accessible to the public. Neither treads nor risers shall deviate more than 0.375 in. (0.95 cm) over the entire run of the stairs. "Demonstration stairs" may use 10-in. (25.4-cm) minimum treads and 7.75-in. (19.7-cm) maximum risers in accordance with IRC Section 311. "Demonstrator" spiral stairs shall comply with the IRC. Ladders or stairs with steeper geometries may be provided as "demonstrators" but the design team should be aware that United States building codes typically do not permit their use to habitable spaces. (IBC, Sec. 1009.3 and IRC, Sec. R311.5)

4.2.2. Handrails

Handrails shall be provided on both sides of stairs or ramps used by the public during the display. All handrails shall be designed in accordance with IBC Chapter 10. (IBC, 1009.11)

4.3 Interior Finishes

Interior finishes must comply with IRC Section R315.

4.4 Glazing

The following hazardous locations are subject to human impact and require safety glazing (see IRC Section 308 for specific details and exceptions).

- Glazing in doors
- Glazing in doors, surrounds, and walls enclosing bathtubs or showers
- Glazing in windows within a 24-in. (61.0-cm) arc of either vertical edge of a door and less than 60 in. (152.4 cm) above the floor
- Glazing within 36 in. (91 cm) of stairways and/or within 60 in. (152.4 cm) of the bottom edge of stair treads when the bottom edge of the glazing is less than 60 in. (152.4 cm) above a walking surface

- Glazing in panels located with all the following conditions present:
    - Pane of glazing is greater than 9 ft^2 (0.836 m^2)
    - Bottom edge of glazing is less than 18 in. (45.7 cm) above the floor
    - Top edge of glazing is greater than 36 in. (91.4 cm) above the floor
    - Walking surface is located within 36 in. (91.4 cm) of the glazing (IRC, Sec. 308.4).

4.5 Roofing

Provide details on the proposed roofing system. All roofing materials shall comply with IRC Chapter 9.

4.6 Foam Plastic

Foam plastics used for building construction shall only be permitted if the foam plastic is isolated from the interior of the building with 0.5-in. (1.27 cm) thick gypsum board. This applies to foams typically used in SIPS wall, floor, and roof systems. Provide documentation to demonstrate compliance (IRC, Sec. R314).

4.7 Exterior Envelope

Provide section detail of proposed wall assembly showing framing, sheathing, water resistive barrier, flashing, and exterior cladding as applicable (IRC, Sec. R703).

4.8 Ceiling Height

Ceiling height shall provide a minimum of 7 ft (213 cm) of headroom (IRC, Sec. R305).

4.9 Skylights

IRC Section R308.6 regulates skylight glazing. Glazing is limited to certain types, and screening under the glazing may be required. Indicate which glazing products are to be used and provide sufficient details in the submitted plans to ensure compliance (IRC, Sec. 308.6).

5. Accessibility

5.1 Accessible Route – Interior

An accessible route shall be provided within the unit to all spaces accessible to the public. Other accessible features may be included in rooms such as kitchens and bathrooms at the discretion of the designers. If any of the features are intended for use by the public, they shall be accessible.

5.2 Accessibility – Habitable Roof Deck and Interior Second Floor/Loft Levels

This building is intended to demonstrate a single-family dwelling that would not normally be regulated by any federal accessibility standard. However, the building is open to the public for educational purposes and must be accessible in all primary function areas. Therefore, any portion of the building where the public is permitted must be on an accessible route. The Americans with Disabilities Act (ADA) requires an elevator to be installed in buildings (funded pursuant to Title II) where an accessible route is required to stories above the first floor (such as the roof deck, second floor, or loft). The 3000-ft^2 exception located in IBC Section 1104.4 Exc. 1 is superseded by Federal regulation.

Following a discussion with a representative of the ADA Assistance Center, it appears acceptable to "demonstrate" a roof deck, loft, or upper level accessed via a stair, or other means of inaccessible access as long as no member of the public, organizers, or team competitors is allowed to access the space during the public display. Any provided means of access shall be fully gated or cordoned off to inhibit entry. Adherence to these guidelines should remove any perception that the upper level is being used as a primary function and therefore subject to the accessibility provisions of the ADA.

5.3 Accessibility – Ramps

The following are the most important regulations regarding ramps.

- A "ramp" is any sloping surface used as part of the circulation path that has a slope in excess of 1:20.
- The slope of a ramp cannot exceed 1:12.
- 60-in. (152.4-cm) long landings are required at the top and bottom of the ramp
- A 60-in. (152.4-cm) by 60-in. landing is required at any point where a ramp changes directions.
- Handrails are required if the ramp's rise exceeds 6 in. (15.2 cm) (American Disabilities Act Accessibility Guidelines [ADAAG], Sec. 4.8 and ANSI A117.1-2003 Section 405).

5.4 Changes In Elevation

All changes in elevation (including even minor changes in areas such as door thresholds) must be considered along an accessible route. Changes not exceeding 0.25 in. (0.635 cm) are acceptable. Elevation changes between 0.25 in. (0.635 cm) and 0.5 in. (1.27 cm) shall be beveled at a maximum of 1:2. Any higher change in elevation exceeding 0.50 in. (1.27 cm) shall be by a ramp with a maximum slope of 1:12 (ADAAG, Sec. 4.5.2).

5.5 Doors and Door Approaches

All doors shall comply with ADAAG Section 4.13 (ANSI A117.1-2003 Section 404). Doors that can be fixed in an open position may be accepted as part of the accessible route if 32-in. (81.3-cm) minimum clearance is provided through the door opening with the door secured in the fully open position.

6. Structural

The structural drawings and calculations included in the construction drawings and specifications set must be stamped by a licensed professional engineer (P.E.). Obtaining the P.E. stamp is the responsibility of the teams, not the Organizers. The Organizers will submit stamped structural drawings and calculations to the NPS for final approval. It is strongly recommended that teams involve a licensed structural engineer throughout the design process, because he or she could require structural design changes that could affect other aspects of the house. In addition to meeting applicable IRC requirements, special attention must be given to the structural design challenges unique to the Solar Decathlon. These challenges include, but are not limited to, the following:

- Increased live loads because of public access to houses
- Necessity for tie-downs because of the lack of a permanent foundation (tie-downs must not penetrate more than 18 in. (45.7 cm) into the National Mall topsoil)
- Use of low-impact footings to protect the National Mall grass
- Unique wind loading conditions because of roof-mounted solar systems
- Increased dead loads because of unusual mechanical and electrical equipment, such as batteries and water storage.

6.1 Prescriptive Requirements

Structural systems shall be designed in accordance with the appropriate prescriptive provisions of the IRC. See alternate materials provisions in Section 6.6. For structural framing, a one-line structural plan view drawing is required at a minimum. Successive plan sheets shall be provided and shall include foundation footings, floor framing, wall locations, and roof framing. All structural components shall be listed including sizes, species and grade, and repetitive spacing (on-center distances). Include details on connections between joists and

beams, floor systems and foundations, walls and floors, rafters and beams, etc. Specify proprietary hangers or other mechanical connections. (IRC, Sec.R301.1)

6.2 Design Loads

The following minimum loads must be used in the structural design:

- Wind: 60 mph (26.8 m/s) (3-second gust), exposure category C (if tie-downs are not used, you must show that there is no overturning or uplifting with a safety factor of 2)
- Railings: 200-lb (890-N) concentrated load applied in any direction at any point at the top of the rail
- Interior Floor, Decks, Ramps: 50 psf (2.39 kPa) live load
- Roof: 20-psf (0.958-kPa) live load
- Soil: 1500-psf (71.8-kPa) load-bearing pressure on top of the soil
- Additional structural design requirements at the post-Event house location (to be determined by the engineer of record).

Structural plans shall indicate the design loads (e.g., 50 psf [2.39 kPa] floors, 100 psf [4.78 kPa] means of egress components, 20 psf [0.958 kPa] snow roof live load) and the location, size, and weight of special loads such as liquid storage tanks, mass or trombe walls, and battery storage racks (IRC, Sec. R310.2).

6.3 Exterior Construction

Structural plans shall include design details for any exterior appurtenances such as decks, stairs, ramps, awnings, canopies, and roof projections (IRC, Sec. R301.1).

6.4 Specific Point Loads

Provide wind-analysis calculations for point-load connections demonstrating the components' abilities to withstand 60-mph (26.8-m/s), exposure category C wind conditions. Provide point-load connection details for all solar panel connections to demonstrate that the connections will resist uplift (IRC, Sec. R301.1).

6.5 Foundation Details

Provide a foundation plan for temporary set up on the National Mall. Plans shall include location and size of all pad footings and required tie-down anchors (e.g., type, number, and installation configuration) to prevent wind uplift or over-turning (IRC, Sec. R401.1 and

R401.2). Please provide consideration for sloping or variable site conditions. The surface of each assigned site on the Mall may vary up to 18 in. (46 cm.) depending upon location.

6.6 Alternate Materials

Alternate materials are permitted as follows.

- Engineered Lumber (e.g., TJIs, LPIs, and BCIs) pursuant to specific manufacturer's design data. The product selected must carry a current International Code Council (ICC) Evaluation Services report. See http://www.icc-es.org/.
- Structurally insulated panel systems (SIPS) pursuant to specific manufacturer's design data. The product selected must carry a current ICC Evaluation Services report. Also be advised that foam plastics must be thermally isolated from the interior of the dwelling (see Section 4.6 for more details).
- Engineered trusses (floor or roof) must be designed in accordance with IRC Sections R502.11 or R802.10 as appropriate. Individual truss reports shall be provided for review and shall bear the seal of a registered design professional (IRC, R104.11).
- Other alternate materials may be permitted if approved pursuant to IRC Section 104.11. It is the responsibility of the applicant to provide adequate proof to document the alternate as meeting the intent of the prescriptive code requirements. The Organizers reserve the right to deny any alternate for failure to clearly demonstrate code equivalence.

6.7 Structural Steel

Provide structural details for load-carrying structural steel assemblies. Include welded or bolted connections within the assembly and where attached to other structures (IRC, R301.1.3).

7. Electrical

7.1 General Requirements

The provisions of the 2005 National Electrical Code will supersede the limited prescriptive electrical requirements contained in Chapters 33-42 of the 2006 International Residential Code.

All houses must meet all applicable electrical requirements stated in the 2005 National Electric Code (NEC2005). Particular attention should be paid to Articles 690, 480, 445, 250, 310, 400, and 240, which refer to photovoltaic system design, storage batteries, generators, grounding, conductors for general wiring, flexible cords and cables, and over-current protection devices, respectively. Teams are also encouraged to follow the guidelines in the following publication: Wiles, John C. (2006). *Photovoltaic Power Systems and the 2005*

National Electric Code: Suggested Practices, Sandia Report SAND2005-0342-N. This publication can be downloaded for free at http://www.nmsu.edu/~tdi/Photovoltaics/Codes-Stds/PVnecSugPract.html.

7.2 Drawing Requirements

The following requirements are in addition to the requirements listed in the "Drawings and Specifications Contest Activity Details" document under the "Electrical" bullet:

- Electrical plan(s) must include layouts of proposed receptacles, switches, light fixtures, smoke alarms, ceiling fans, etc.
- Provide details on the proposed PV system along with a key for symbols used in the drawings. Such details shall include information on the photovoltaic panels, distribution (e.g., wiring, inverters, switch gear, and over-current protection), and storage equipment. (IRC, Sec. R106.1.1).

7.3 Outdoor Receptacles

Any receptacles used on the exterior of the building must be ground-fault circuit-interrupter (GFCI) protected. Enclosures provided must be suitable for damp locations. (IRC, Sec. E3802.3)

7.4 Arc-Fault Circuit Protection

Any AC circuit providing power to bedrooms shall be protected with arc-fault circuit protection (IRC, Sec. E3802.12).

7.5 Ground-Fault Circuit Protection

Any AC receptacles located in kitchens or bathrooms shall be GFCI protected (IRC, Sec. 3802.1 and 3802.6).

7.6 Equipment Listings

All equipment shall carry an approved testing agency's listing. Provide manufacturer's listing information for the PV equipment selected. (IRC, Sec. E3303.3)

7.7 Battery Enclosure Separation

All battery compartments shall be provided with the equivalent of 5/8-in.(1.59 cm) Type X gypsum board placed on the interior of the compartment on all walls and floors common to the interior of the building. Any penetrations into the interior of the building shall be sealed to resist the passage of smoke, flame, and hot gasses with approved materials.

Battery compartments containing more than 100 gallons (379 liters) total liquid electrolyte capacity shall be separated from the remainder of the building by a 2-hour fire barrier constructed in accordance with Section 706 of the 2006 International Building Code. Openings and penetrations in the fire barrier shall be protected as required by Sections 706.7 and 706.8 respectively.

7.8 Battery Enclosure Ventilation

All battery enclosures shall be provided with either passive or active ventilation. A battery cabinet placed in an equipment room must meet the same ventilation requirements as the room in which the cabinet is placed. The only difference is that, for a battery cabinet in an equipment room, the intake is typically the equipment room air; for a battery rack in an equipment room, the intake is typically the outside air. This distinction also applies to exhaust air locations. The following ventilation requirements apply to all battery types.

PASSIVE VENTILATION REQUIREMENTS:

Passive ventilation shall consist of a lower gravity vent and an upper gravity vent.

The top of the lower gravity vent shall be located no more than 12 in. (30.5 cm) from the lowest point of the battery enclosure. The vent shall be unobstructed to allow fresh air intake into the enclosure and shall be sized to provide a minimum of 28 $in.^2$ (181 cm^2) of net free ventilating area.

The upper vent shall be located in either the battery enclosure ceiling or in a battery enclosure sidewall. A ceiling vent shall be located at the highest point of the battery enclosure ceiling. The top of a sidewall vent shall be coincident with highest point of the battery enclosure ceiling. The vent shall discharge at least 5 ft (1.52 m) away from sources of air intake into the building and shall be sized to provide a minimum of 28 $in.^2$ (181 cm^2) of net-free ventilating area. If the upper vent is ducted outside, the duct must be level or sloped upward from the battery room to the outside. These requirements prevent the accumulation of hydrogen gas near the ceiling of a battery enclosure.

ACTIVE VENTILATION REQUIREMENTS:

Active ventilation shall consist of a lower fan-powered vent and an upper gravity vent.

Active ventilation shall be powered by a continuously operating, DC brushless fan. The fan shall provide a minimum of 1 cfm (0.47 L/s) of air supply for each square foot of floor area in the battery enclosure. The fan shall be oriented to generate a positive pressure in the battery compartment. The top of the fan inlet shall be located no more than 12 in. (30.5 cm) from the lowest point of the battery enclosure.

The upper vent shall be located in either the battery enclosure ceiling or in a battery enclosure sidewall. A ceiling vent shall be located at the highest point of the battery enclosure ceiling. The top of a sidewall vent shall be coincident with the highest point of the battery enclosure ceiling. The vent shall discharge at least 5 ft (1.52 m) away from sources of air intake into the building and shall be sized to provide a minimum of 28 $in.^2$ (181 cm^2) of net-free ventilating area. If the upper vent is ducted outside, the duct must be level or sloped upward from the battery room to the outside. These requirements prevent the accumulation of hydrogen gas near the ceiling of a battery enclosure.

7.9 Batteries

For regular lead acid systems with greater than 50 gallons of electrolyte, refer to IFC 608.4 Spill Control and Neutralization, which states, "An approved method and materials for the control and neutralization of a spill of electrolyte shall be provided. The method and materials shall be capable of controlling and neutralizing a spill from the largest lead-acid battery to a pH between 7.0 and 9.0."

For VRLA Systems of 50 gallons or more, refer to IFC 609.5 Neutralization, which states, "An approved manual method and materials for the neutralization of a release of electrolyte shall be provided. The method and materials shall be capable of controlling and neutralizing a release of 3 percent of the capacity of the largest VRLA cell or block in the room to a pH between 7.0 and 9.0."

Refer to the "Battery Requirements and Guidelines" supplemental document.

7.10 Photovoltaics

Particular attention should be paid to Articles 690, 480, 445, 250, 310, 400, and 240 of the 2005 NEC, which refer to photovoltaic system design, storage batteries, generators, grounding, conductors for general wiring, flexible cords and cables, and overcurrent protection devices, respectively. Teams are also encouraged to follow the guidelines in the following publication: Wiles, John C. (2006). *Photovoltaic Power Systems and the 2005 National Electric Code: Suggested Practices,* Sandia Report SAND2005-0342-N. This publication can be downloaded for free at http://www.nmsu.edu/~tdi/Photovoltaics/Codes-Stds/PVnecSugPract.html.

8. Mechanical

8.1 Drawing Requirements

Provide a key for symbols used in the drawings (IRC, Sec. R106.1.1).

8.2 Return Air

Return air shall not be taken from a bathroom, kitchen, mechanical, or furnace room. Return air shall not be taken where there is a presence of flammable vapors (e.g., battery storage room) (IRC, Sec. M1602.2, Items 2 and 4).

8.3 Outside Air

8.3.1. Intake Location

Outside air shall not be taken closer than 10 ft (304.8 cm) from an appliance or plumbing vent, or discharge outlet of an exhaust fan (unless the intake is located at least 3 ft [91.4 cm] below the vent or fan discharge) (IRC, Sec. M1602.2, Item 1).

8.3.2. Screens

Outside air inlets shall be provided with a screen with openings 0.25 in. (0.64 cm) to 0.5 in. (1.27 cm) (IRC, Sec. M1602.3).

8.4 Bathroom Ventilation

Bathrooms shall be provided with mechanical ventilation systems capable of providing 50 cfm (23.6 L/s) for intermittent ventilation or 20 cfm (9.4 L/s) for continuous ventilation, or provide windows allowing 1.5 ft^2 (0.139 m^2) opening for natural ventilation (IRC, Sec. R303.3).

9. Solar Mechanical

9.1 Drawing Requirements

Provide plan details for any proposed solar mechanical systems. Provide details on collectors, fluid distribution, heat exchangers, etc. along with a key for symbols used in the drawings (IRC, Sec. 106.1.1).

9.2 Cross Connection

Provide details for the solar hot water system. Provide details indicating if potable water or other heat transfer liquids will be employed. If other than potable water is used, an approved heat exchanger shall be employed to isolate potable water from transfer fluids (IRC Section R106.1.1).

9.3 Access

Solar collectors, controls, dampers, fans, and pumps shall be accessible for inspection, maintenance, repair, and replacement. (IRC, Sec. M2301.2.1).

9.4 Roof Mounted Collectors

The roof shall be constructed to support all loads imposed by the collectors. If collectors are intended to serve as the roof covering, documentation shall be provided to determine compliance with the roofing provisions in IRC, Chapter 9. If the collectors will be placed over the roof covering, the collectors and supporting structure shall be constructed of noncombustible material or fire-retardant-treated wood equivalent to that required for the roof covering (IRC, Sec. M2301.2.2).

9.5 Pressure and Temperature Relief

Pressure- and temperature-relief valves shall be provided for components under pressure. Relief devices shall be installed in sections of the system so that a section cannot be valved off or isolated from a relief device (IRC, Sec. M2301.2.3).

9.6 Vacuum Relief

A vacuum relief valve shall protect system components that might be subjected to pressure drops below atmospheric pressure during operation or shutdown. Plans shall indicate if this system is subject to vacuum conditions (IRC, Sec. M2301.2.4).

9.7 Expansion Tanks

Expansion tanks in solar systems shall be installed in accordance with IRC, Section M2003 in closed-fluid loops that contain heat transfer fluid (IRC, Sec. M2301.2.6).

9.8 Solar Loop Isolation

Valves shall be installed to allow the solar collectors to be isolated from the remainder of the system (IRC, Sec. M2301.2.8).

9.9 Maximum Temperature Limitation

Systems shall be equipped with means to limit the maximum water temperature of the system fluid entering or exchanging heat with any pressurized vessel inside the dwelling to 180°F (82°C). This protection is required in addition to required temperature and pressure relief valves in IRC, Section M2301.2.3. (IRC, Sec. M2301.2.9.).

9.10 Collector and Thermal Storage Unit Labeling

Collectors and storage units shall be listed and labeled to show the manufacturer's name, model number, serial number, collector weight, collector maximum allowable temperatures and pressures, and the type of heat transfer fluids that are compatible with the collector and storage units. (IRC, Sec. 2301.3)

9.11 Prohibited Heat Transfer Media

Flammable gasses and liquids shall not be used as heat transfer fluids (IRC, Sec. M2301.4).

9.12 Backflow Prevention

All connections from the potable water supply to solar systems shall comply with IRC, Section P2902.4.5 (IRC, Sec.M2301.5).

10. Plumbing

10.1 Drawing Requirements

The following requirements are in addition to the requirements listed in the “Drawings and Specifications Contest Activity Details” document under the “Mechanical and Plumbing” bullet.

- Provide a labeled isometric diagram of the proposed plumbing system for review. Clearly indicate waste lines, vent lines, potable water supply, heat exchange equipment, and the type of any heat exchange fluid other than potable water.
- Provide a key for symbols used in the drawings (IRC, Sec. 106.1.1).

10.2 Water Closet Demonstration

Water closets (W.C.) are installed for demonstration only and shall not be connected to any portion of the gray water disposal system. The W.C. shall be attached to a PVC or ABS 4-in. (10.2-cm) to 3-in. (7.62-cm) water-closet flange provided with a capped end. The cap shall be located as close as possible to the flange fitting. No structural member shall be cut or otherwise damaged to accommodate the W.C. flange assembly.

10.3 Plumbing Wall – Structural

Recommendation: Create a dedicated plumbing wall with thickness sufficient to allow pipe penetrations within the studs not exceeding 60% of the stud width in nonbearing walls (IRC, Sec. 602.6).

10.4 Shower Mixing Valves

Shower mixing valves shall be pressure balanced, thermostatic mixing, or a combination of the two, with the high limit set at 120°F (48.9°C) to prevent scalding (IRC, Sec. P2802.3 and P2708.3).

10.5 Backflow Prevention

Backflow prevention is required to isolate the potable water supply from the solar systems. See IRC Section P2902.2 for permissible devices. Because this project uses supply tanks for potable water, the use of a separate and isolated fill system for the solar component may be deemed acceptable backflow prevention (IRC, Sec. P2902.2).

10.6 Supply

No additives of any kind may be added to the water in the team's supply tank. This water is not for consumption at any time. Teams will be required to provide the tank and support this tank so that it does not damage the National Mall turf.

10.7 Waste

All substances used in combination with water to clean the house, dishes, utensils, etc., must be nontoxic and preferably biodegradable. Teams could incur a point penalty for any toxic substances that are found in the wastewater tank.

10.8 Rainwater Collection

Rainwater collection system design and installation must be approved and stamped by a public health official. Because of Department of Public Health rules and concerns, unapproved rainwater collection systems will not be allowed. The public health official's statement of approval must clearly indicate which applications are approved for the particular system.

11. Material Safety

11.1 Thermal Storage

All thermal storage devices ("mass") must be made of stable, nontoxic materials. Material Safety Data Sheets (MSDS) must be submitted for all heat transfer fluids for approval. All liquid-based thermal storage systems must be marked with the NFPA's Hazard Warning Diamond appropriate to the technology.

11.2 Paint Disposal

Teams are not permitted to dispose of paint on the National Mall. Teams may either take unused paint home or find a local facility that disposes of or recycles paint.

11.3 MSDS

Material Safety Data Sheets (MSDS) are required for all materials to be used at the Event that require an MSDS, such as cleaning solvents, glycol, rubber cement, rubbing alcohol, etc.

12. Moveable Features

Teams planning to move or transform major components of their houses outside of the Assembly and Disassembly phases are required to obtain special approval from the Organizers' Primary Safety Officer. Moving rooms, moving walls, changeable façades, collapsible spaces, and folding beds are some possible design features meeting this description. This message does not apply to smaller, more typical house features that may be reconfigured such as awnings, operable windows and window coverings, and doors. Qualifying features only include larger, more unusual, and potentially more dangerous features. The following rules apply to qualifying features.

- After the houses are assembled on the Mall, we will inspect every house and inform each team whether it has any qualifying features.

- If you would like us to try to determine before the Event whether your house has any qualifying features, please contact sdrules@nrel.gov to inquire.
- Although we cannot thoroughly evaluate the safety of a particular house feature until we see it operating, we will try to tell you with a reasonable degree of confidence whether certain features are subject to these rules.
- Qualifying features shall not be reconfigured during impound.
- Qualifying features shall not be reconfigured during public tours unless approved by the Organizers' Primary Safety Officer. To receive approval, a team must submit a safety plan describing how it will ensure safety during the movement of qualifying features, it must demonstrate the successful execution of the safety plan at some point before public tours begin, and it must continue to demonstrate the successful execution of the safety plan during public tour periods. If, at any time, the Primary Safety Officer witnesses unsafe conditions, he or she may prohibit the movement of qualifying features during public tours for the duration of the event."